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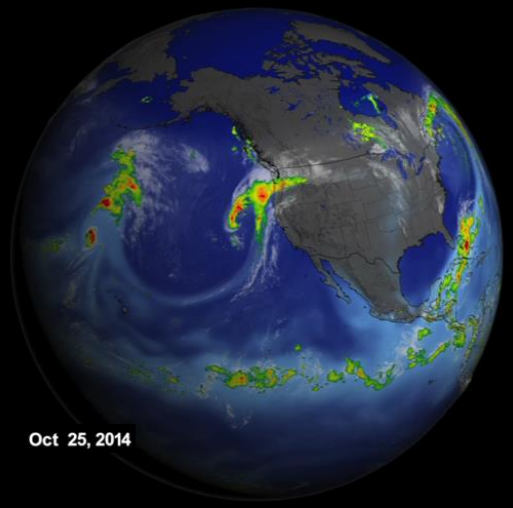
Duane Waliser



Improving S2S Forecasting: The Science Perspective

CAN WE REALLY PREDICT THE WEATHER? THE LATEST IN FORECASTING
Sacramento Convention Center, Sacramento, CA
November 9, 2017

Acknowledgements: B. Guan, M. DeFlorio, M. Ralph, S2S Project, J.Jones/DWR, NASA

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Outline

- What is ”S2S” forecasting?
  - ✓ S2S definition
  - ✓ How can we predict so far into future?
  - ✓ Use hurricanes as an illustrative example and to introduce MJO
  - ✓ Highlight MJO impact on long-lead mid-latitude forecasts
- What does the U.S. NAS say about S2S?
- What is the WMO doing about S2S?
- What are we doing about S2S and ARs?
  - ✓ Science: Quantifying potential S2S forecast skill for CA
  - ✓ Application: Experimental S2S AR forecast activity for CA

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Forecast Lead Times

- Weather 0-14 Days
- **Subseasonal** **2-12 Weeks**
- **Seasonal** **3-12 Months**
- Interannual 1 year - Decade
- Climate Decades - Centuries

Subseasonal to Seasonal (S2S) 2 weeks -12 months

p.s. "subseasonal" aka "intraseasonal"

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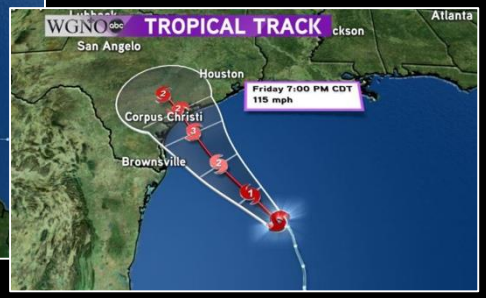
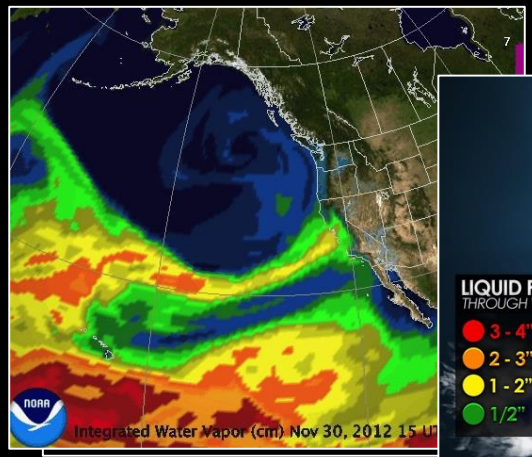
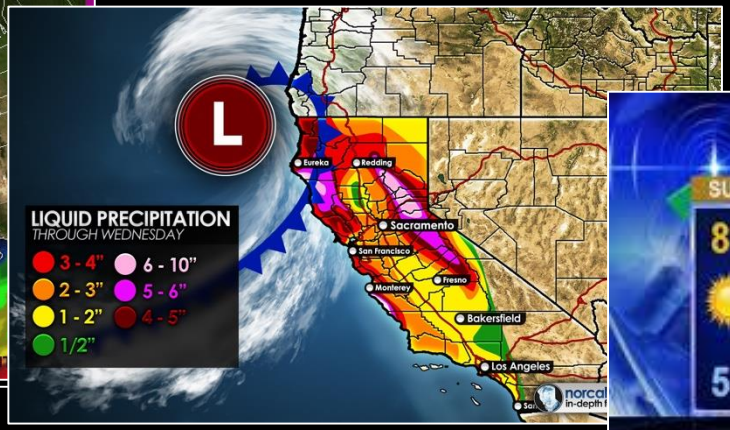
Weather Forecasts

0-14 Days

Hurricanes







Atmospheric Rivers

… cold spells, heat waves, thunderstorms/tornados, nor'easters, santa ana winds, etc

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S2S Forecasts: Hurricanes

2 –12 weeks

- How can we predict hurricanes 2 weeks to 3 months in the future?
- Rather than try to predict the occurrence or evolution of a single hurricane at such long leads, we predict the likelihood of a hurricane or expected frequency of hurricanes?
- Can we do that? How do we do that?

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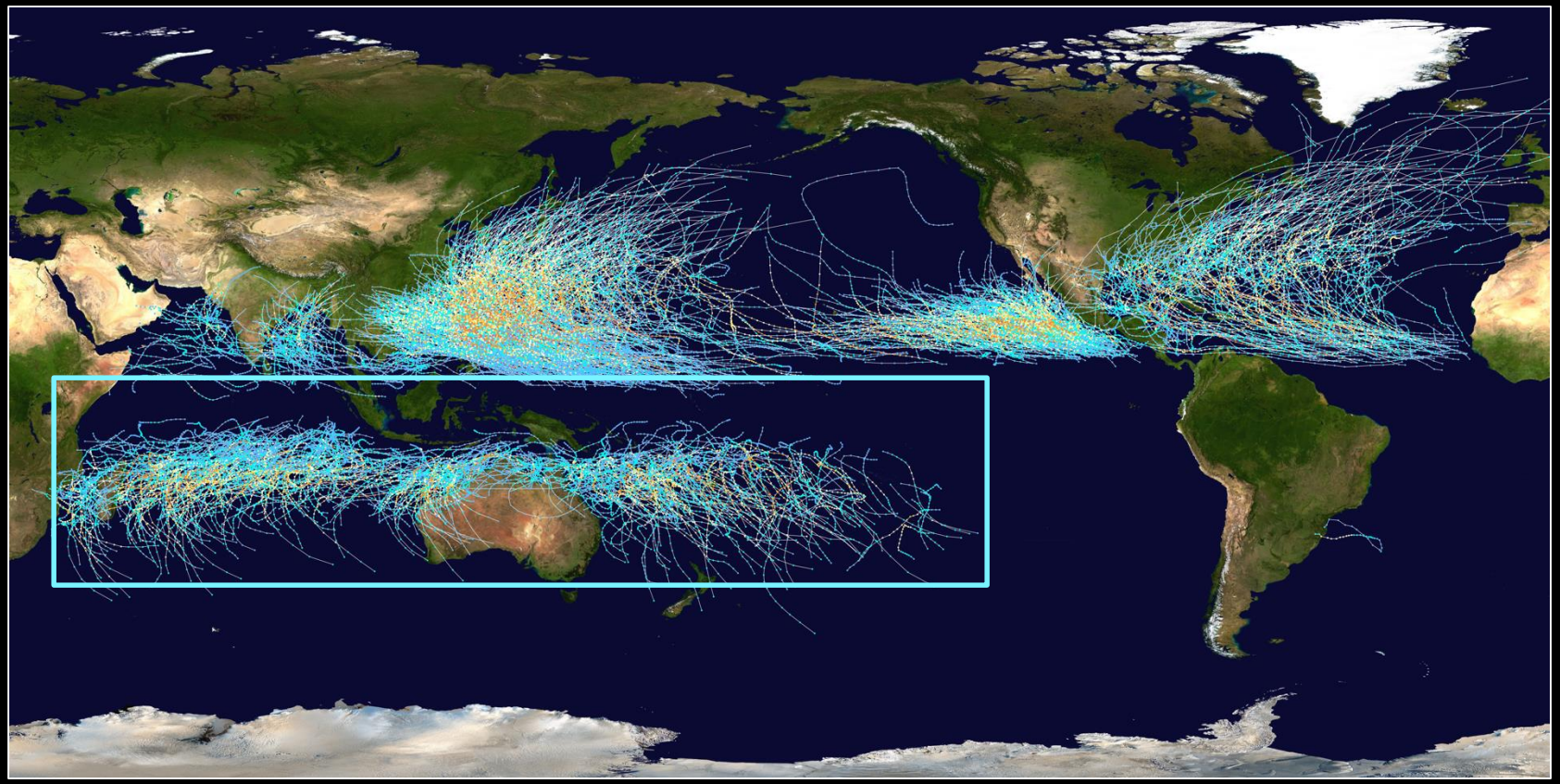
S2S Forecasts: Hurricanes

Typical Distribution



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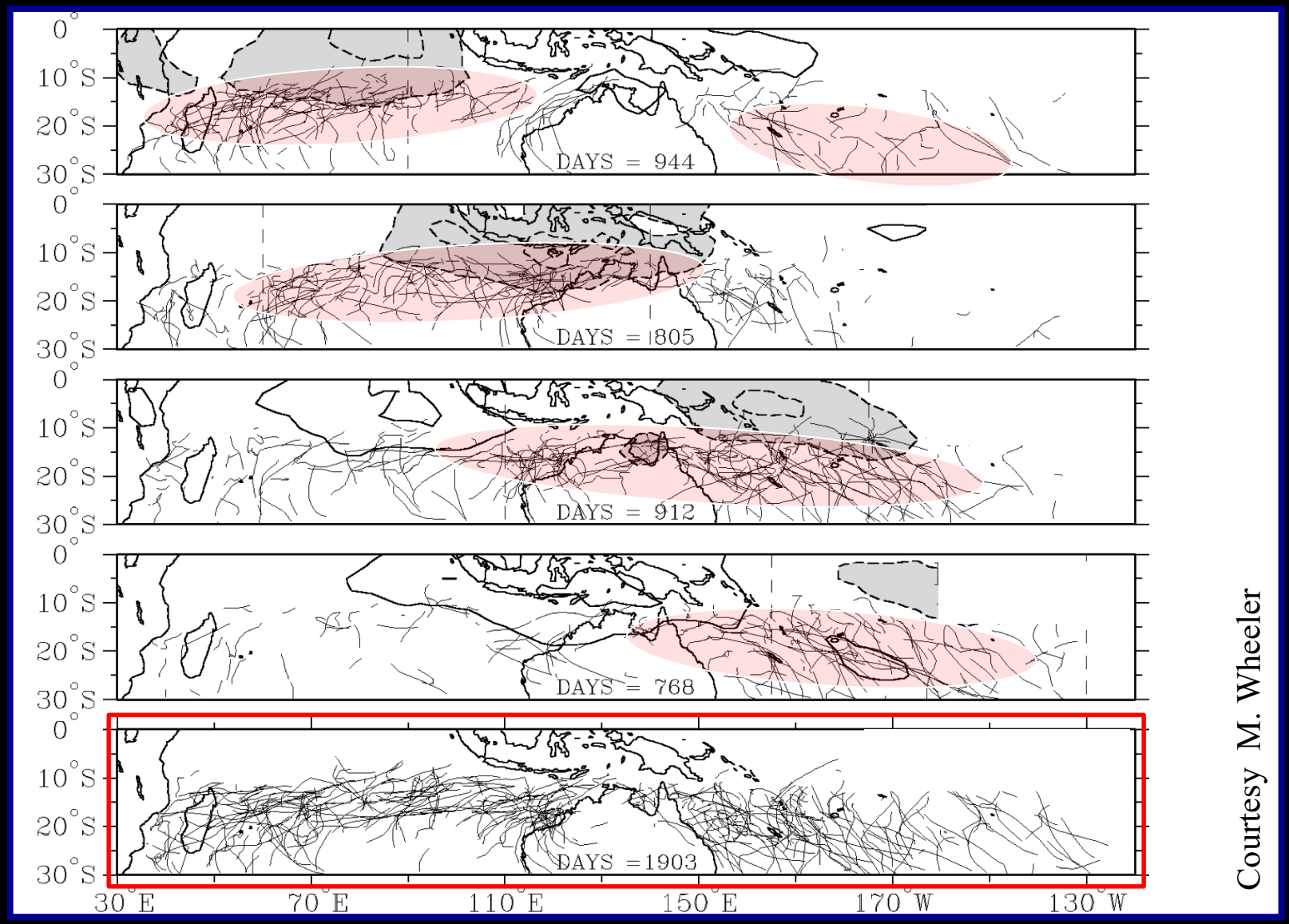
S2S Forecasts: Hurricanes

More or Less than Usual



Courtesy M. Wheeler

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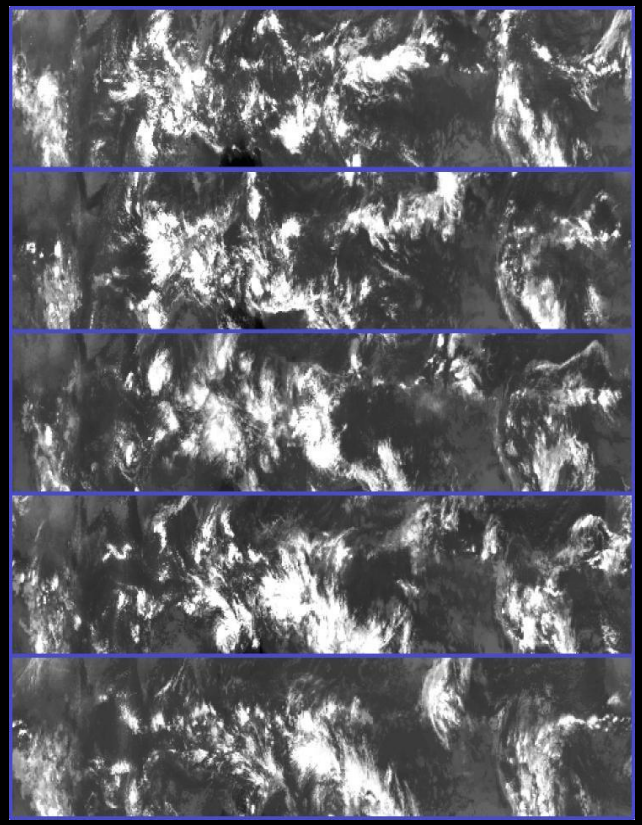
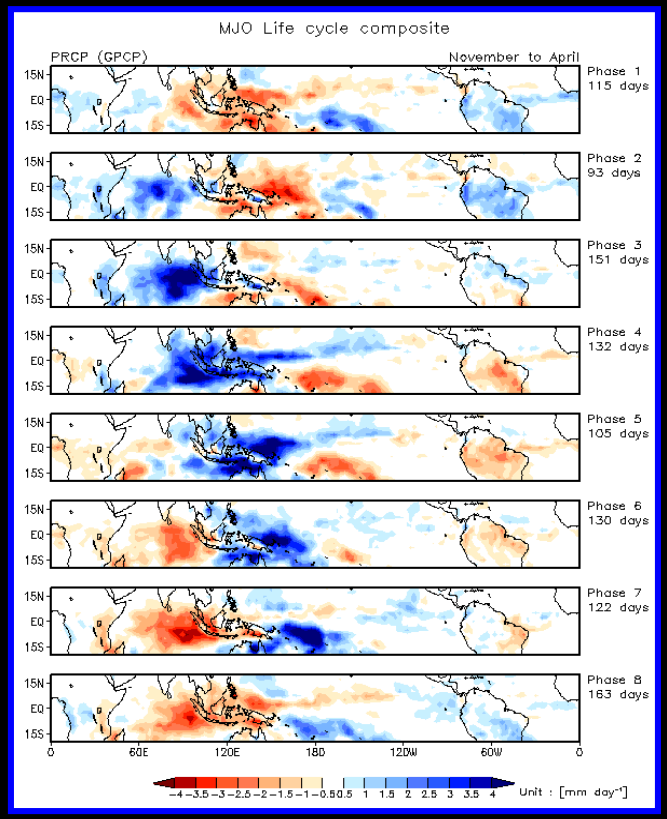
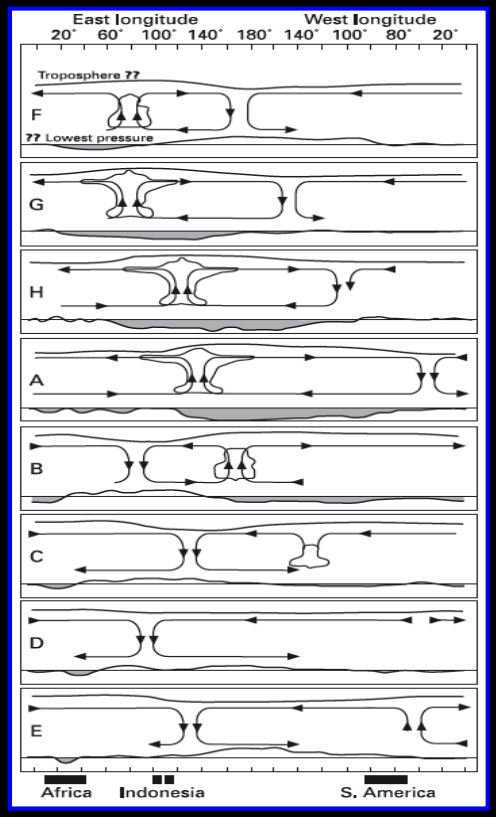
Madden-Julian Oscillation (MJO)







Madden & Julian, 1972

Important to S2S :

- MJO Life Cycle ~40-50 Days
- Intermittently Occur ~2-5 times/year

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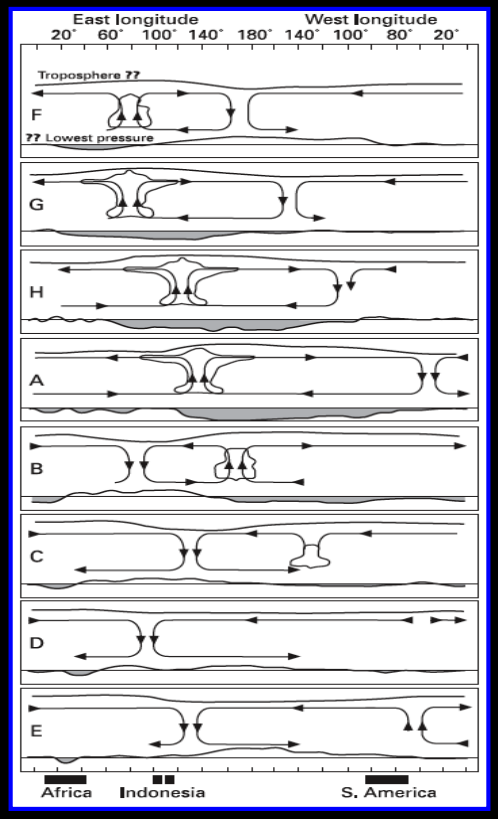
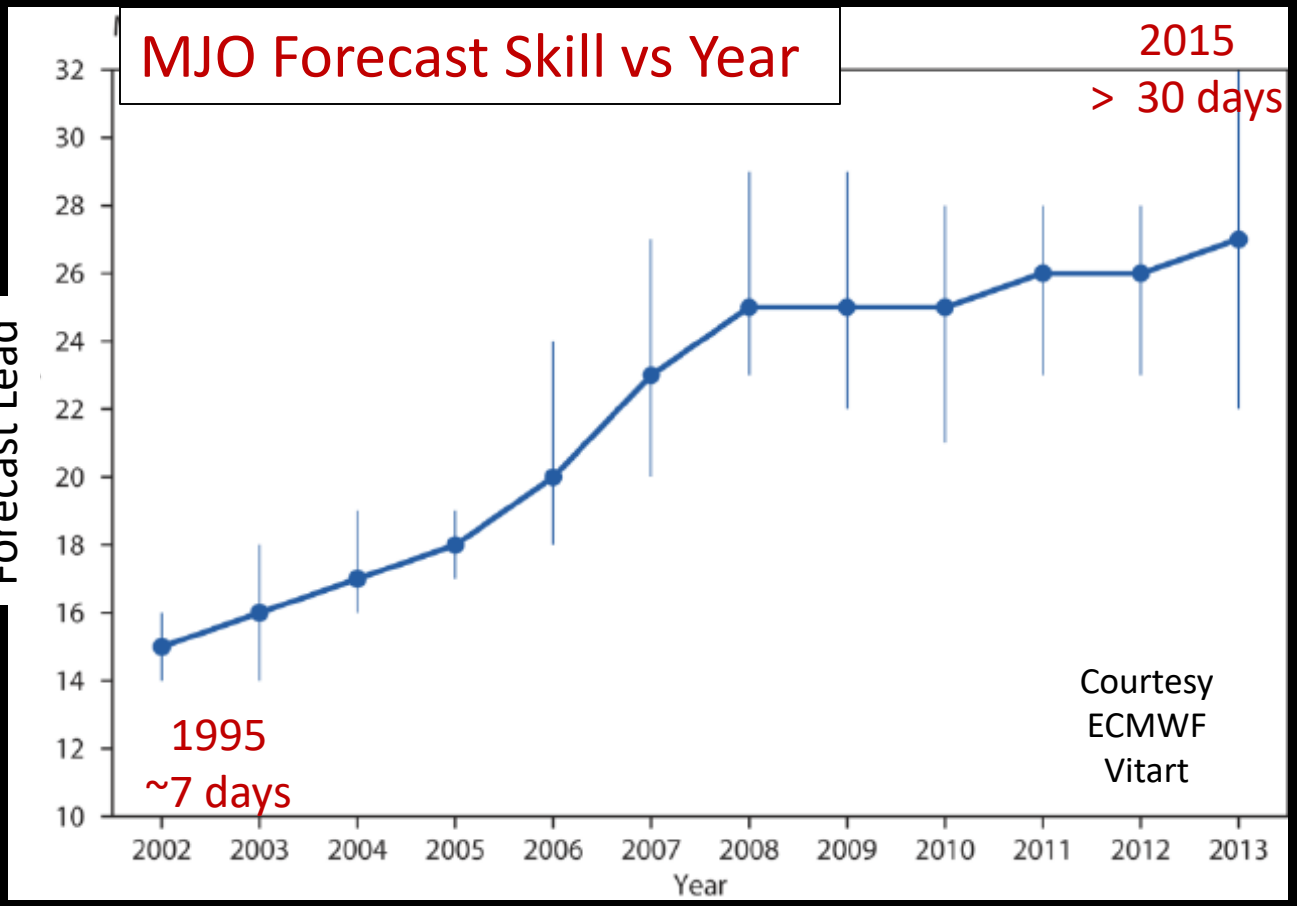
Predicting the MJO

Up to 4 Weeks Ahead



Madden & Julian, 1972



Great Progress in the last two decades!

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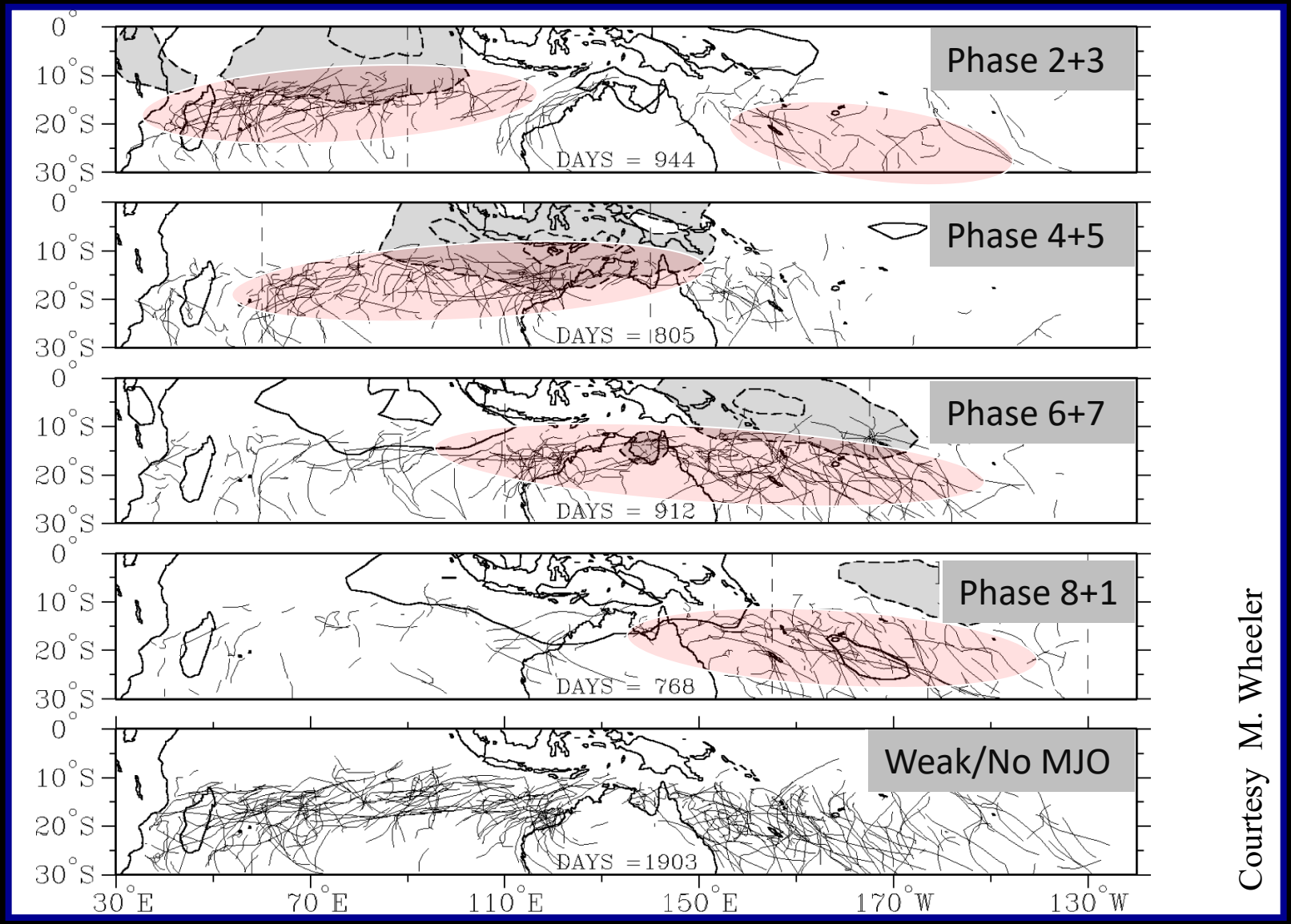
S2S Forecasts: Hurricanes & MJO

Predicting *More or Less than Usual*

Up to 4 Weeks Ahead



Courtesy M. Wheeler

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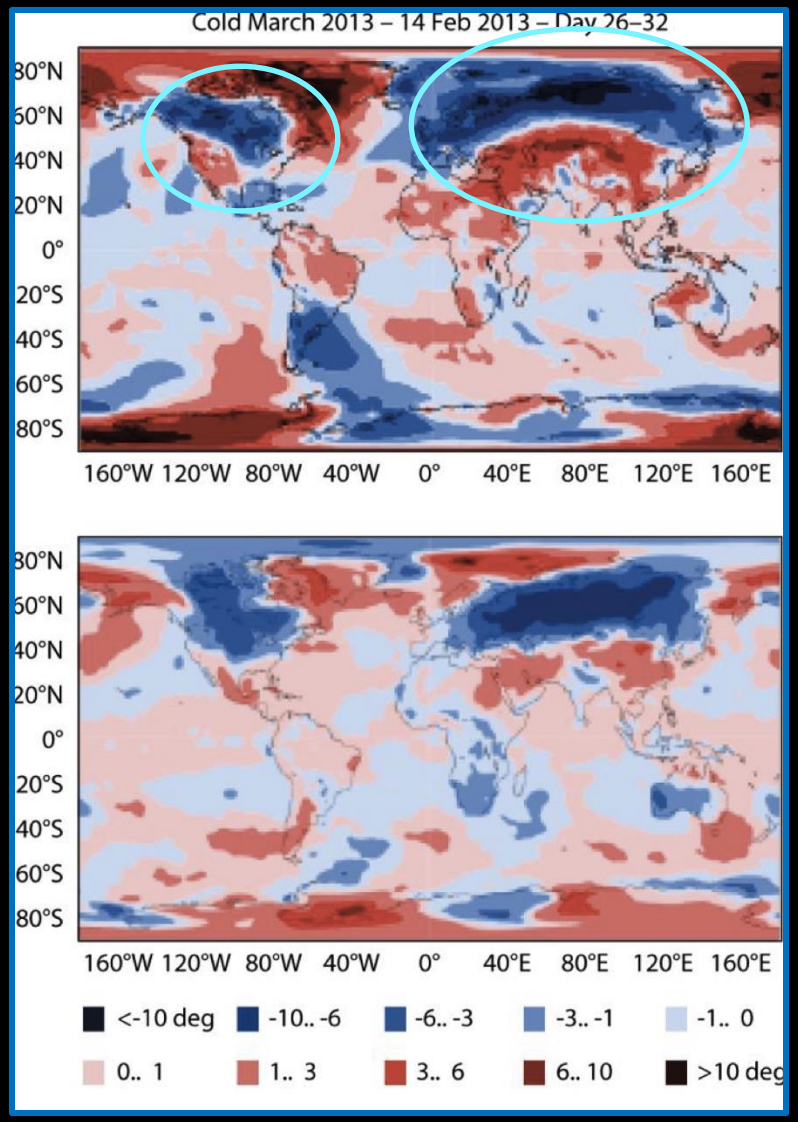
S2S Forecasts: MidLatitudes & MJO

Predicting *Cold Spell 3-4 Weeks Ahead*



Vitart and Robertson, 2017

Cold March 2013 in
N. America and N. Asia

NCEP forecast at lead times
26-32 Days

(when considering accurate
forecasts of the MJO)

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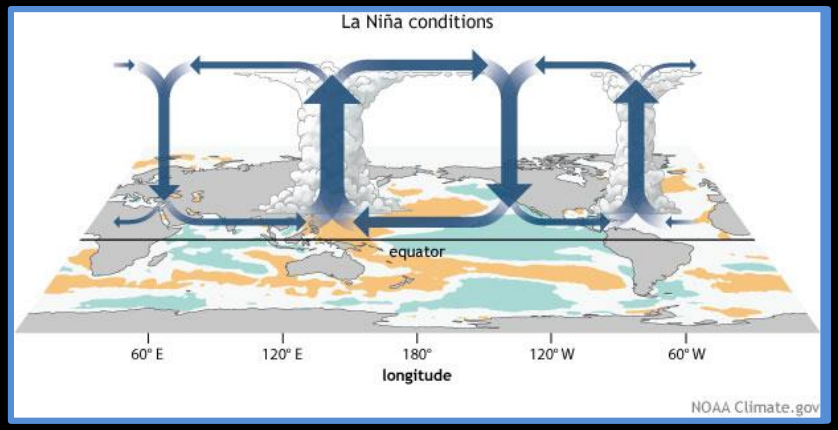
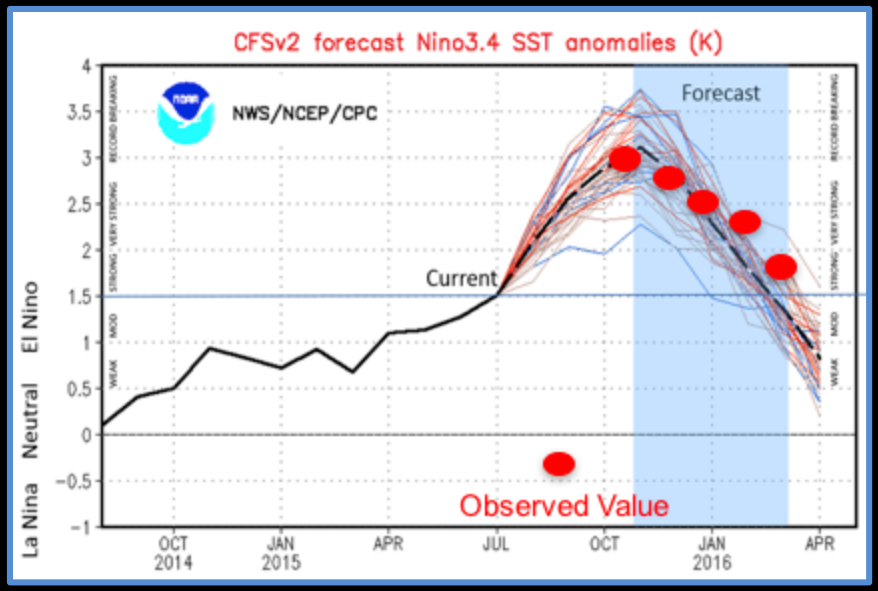
S2S Forecasts: 3-9 Months?

El Nino and La Nina is expected to provide an analogous source of predictability at lead times of *3-9 months*

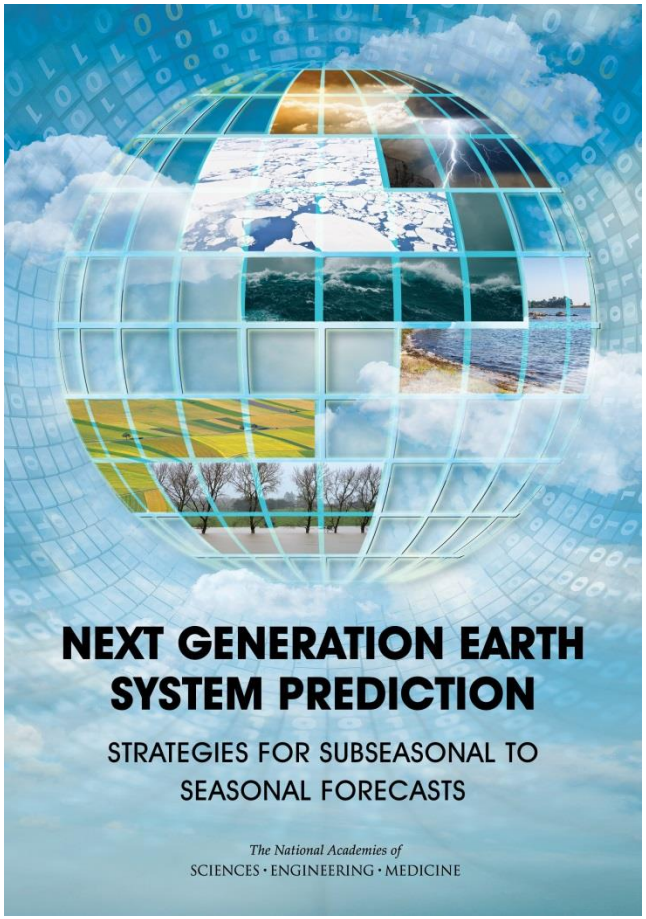




U.S. National Academy of Sciences Study on S2S Forecasting

Bold Vision: S2S forecasts will be as widely used a decade from now as weather forecasts are today

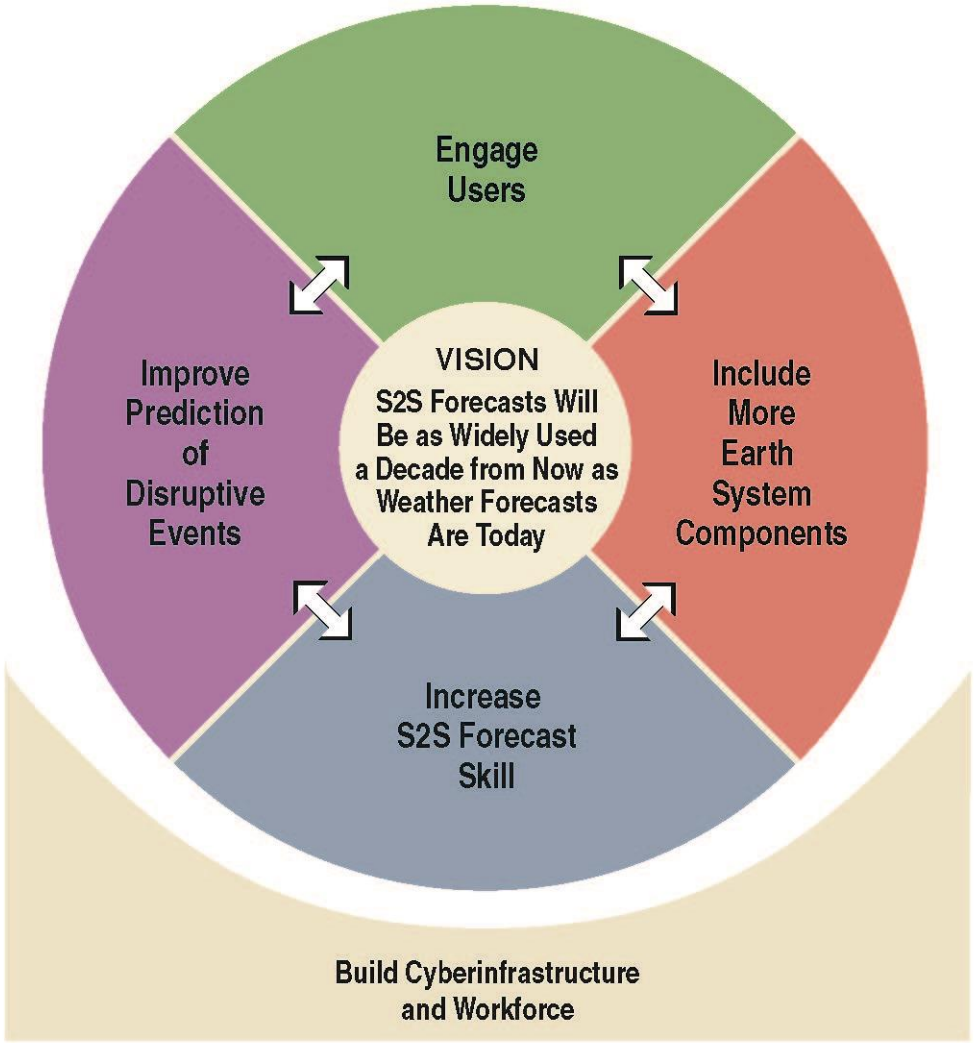
- Benefiting business, government and individuals
- Fulfilling this vision will take sustained effort and investment



2016

Supported by NASA, ONR and Heising-Simons Foundation

Fulfilling the Vision: Research Strategies



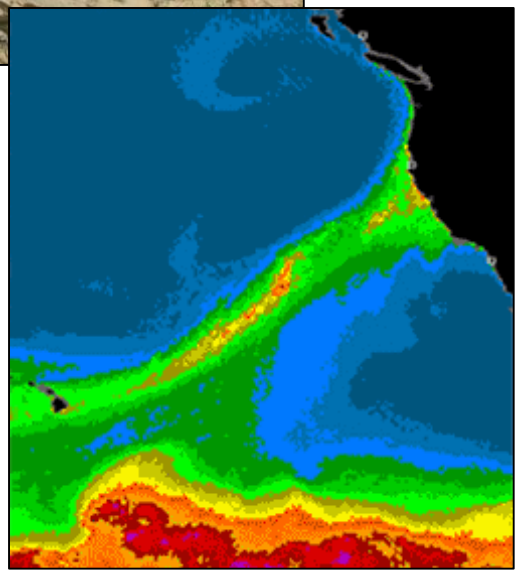
1. **Engage Users**
2. **Increase S2S Forecast Skill**
3. Improve Prediction of Disruptive Events
4. Include More Earth System Components

Research Strategy 1 : Engage Users

Example - Water Resource Management

Improved S2S predictions of drought and the probability of atmospheric river events will:

- Support improved management of reservoirs, including drought management, flood control, and planning for hydropower
- Need engagement to understand critical decisions and to produce forecast information that fits water project/agency location and timing needs

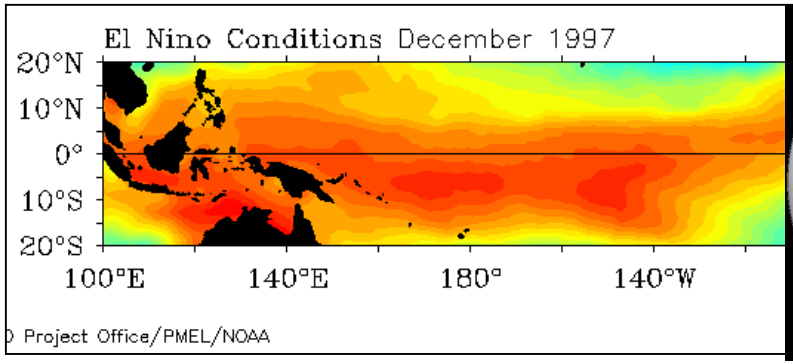


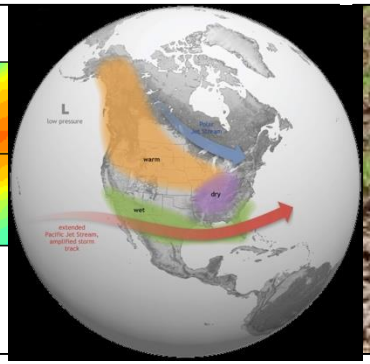
Research Strategy 2: Increase S2S Forecast Skill

1) Improve **understanding** of sources of S2S predictability
   - Natural "oscillations" e.g. ENSO, MJO, QBO, IOD, etc
   - Slowly varying surface processes, e.g. snowpack, sea ice, soil moisture, etc
2) Improve **models** to better represent these processes
3) Improve **observations** to better measure these processes.

For long-lead S2S predictions, 1-3 mean <u>globally</u>.

What happens far away matters to a local S2S forecast.





World Meteorological Organization (WMO)

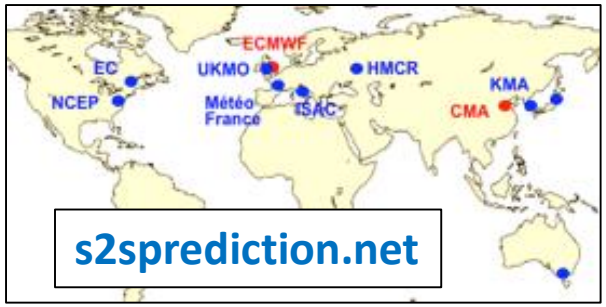
- **To improve S2S forecast skill ….**
- **To promote use of S2S forecasts by decision makers…**

Developed a 10-year (2013-2023) research and applications initiative referred to as the **“S2S Prediction Project”**

- Involves 11 global operational forecast centers
- A research quality database of hindcasts/forecasts
- Organizing research to improve S2S forecasts
- Engaging potential users, with trainng and pilot projects

WCRP World Climate Research Programme

WWRP WORLD WEATHER RESEARCH PROGRAMME



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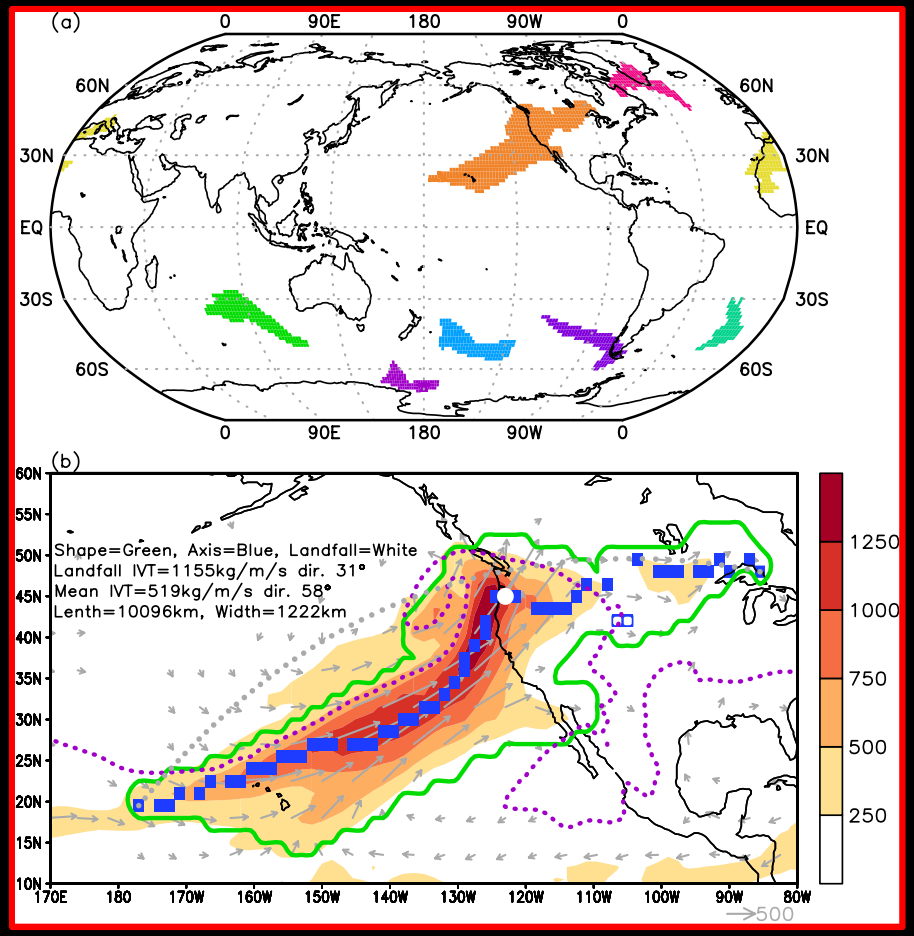
What are we doing about S2S and ARs?



Guan and Waliser (2015)

Global AR Detection Algorithm

- Based on modern understanding and datasets (e.g. Ralph et al. 2004).
- Developed for global & regional studies
- Applied to Reanalyses and Weather/Climate Models
- Code and databases available at:
  - https://ucla.box.com/ARcatalog

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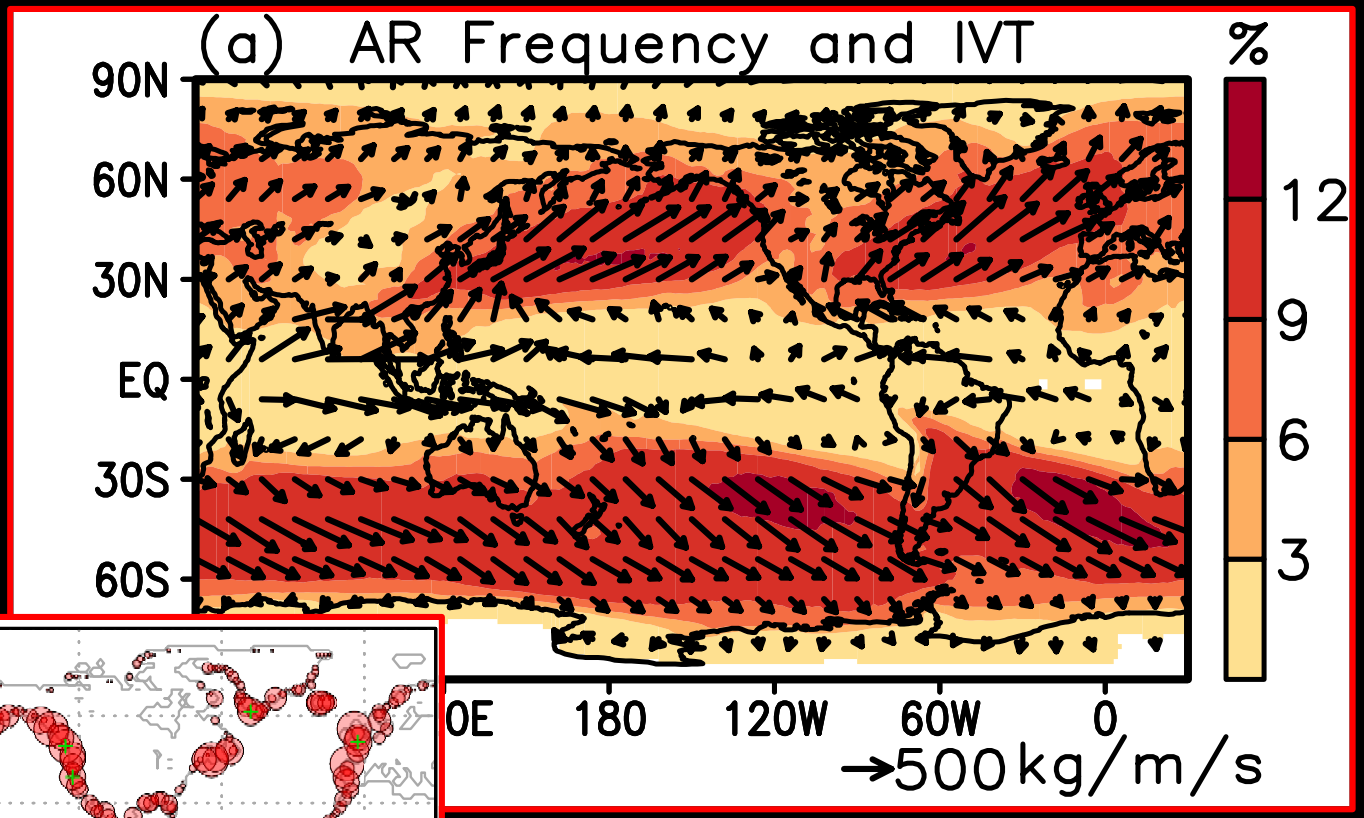
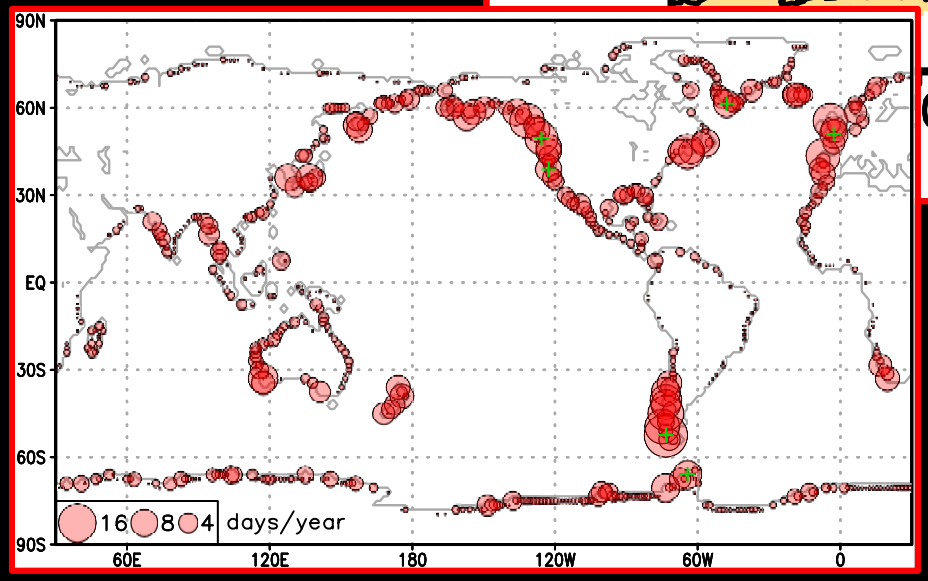
AR Distribution & Landfalls





1997-2015

Guan and Waliser (2015)

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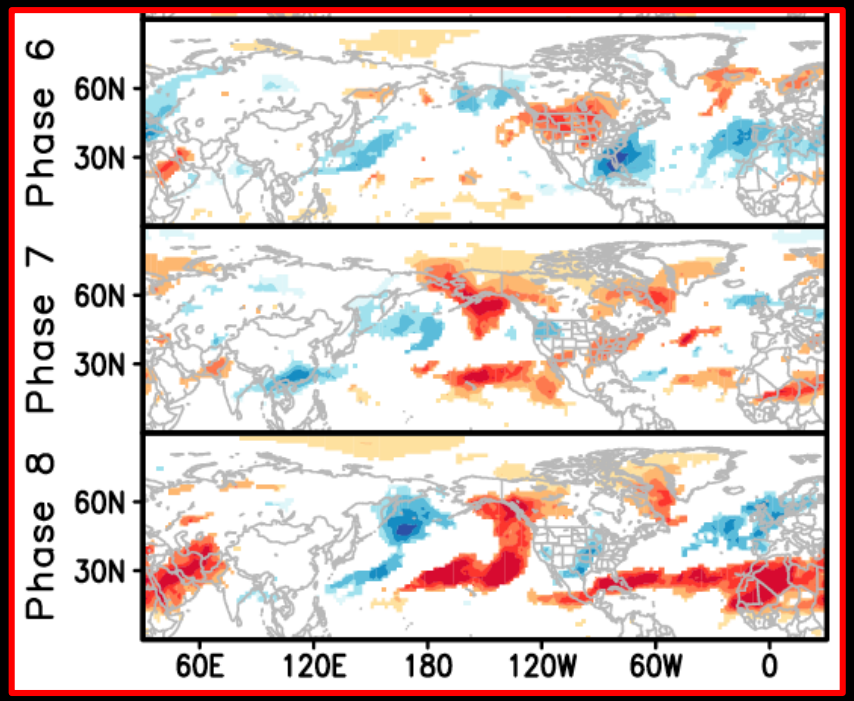
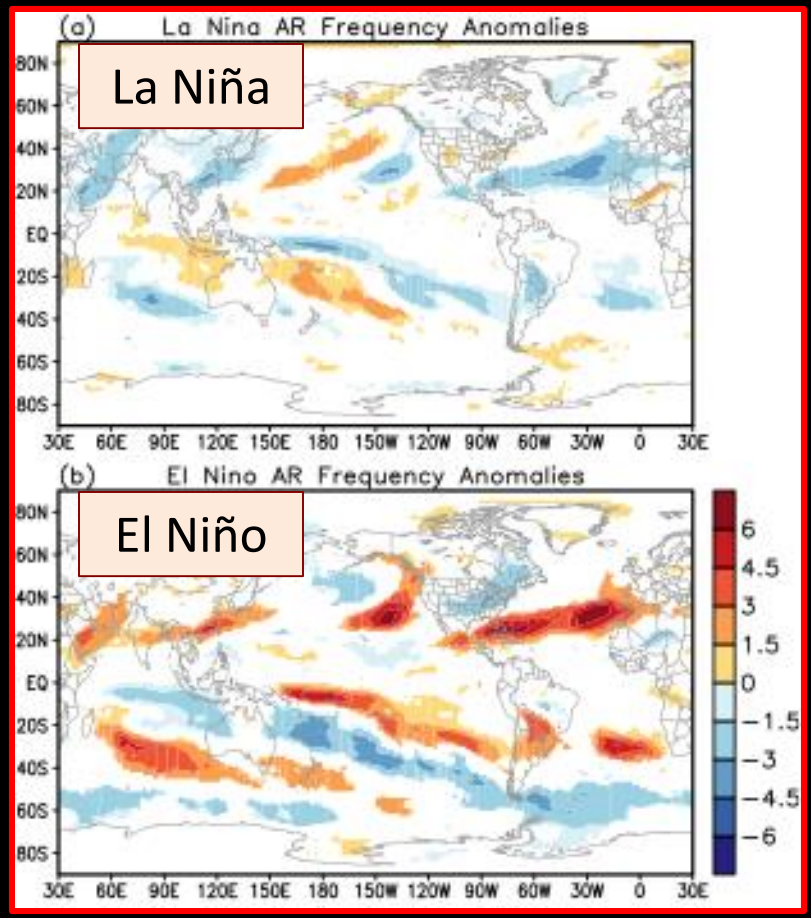
S2S Forecasts: ARs
Predicting *More or Less than Usual*

Madden Julian Oscillation (MJO)



El Nino Southern Oscillation (ENSO)



Similar to hurricanes – MJO and ENSO modulate number of ARs

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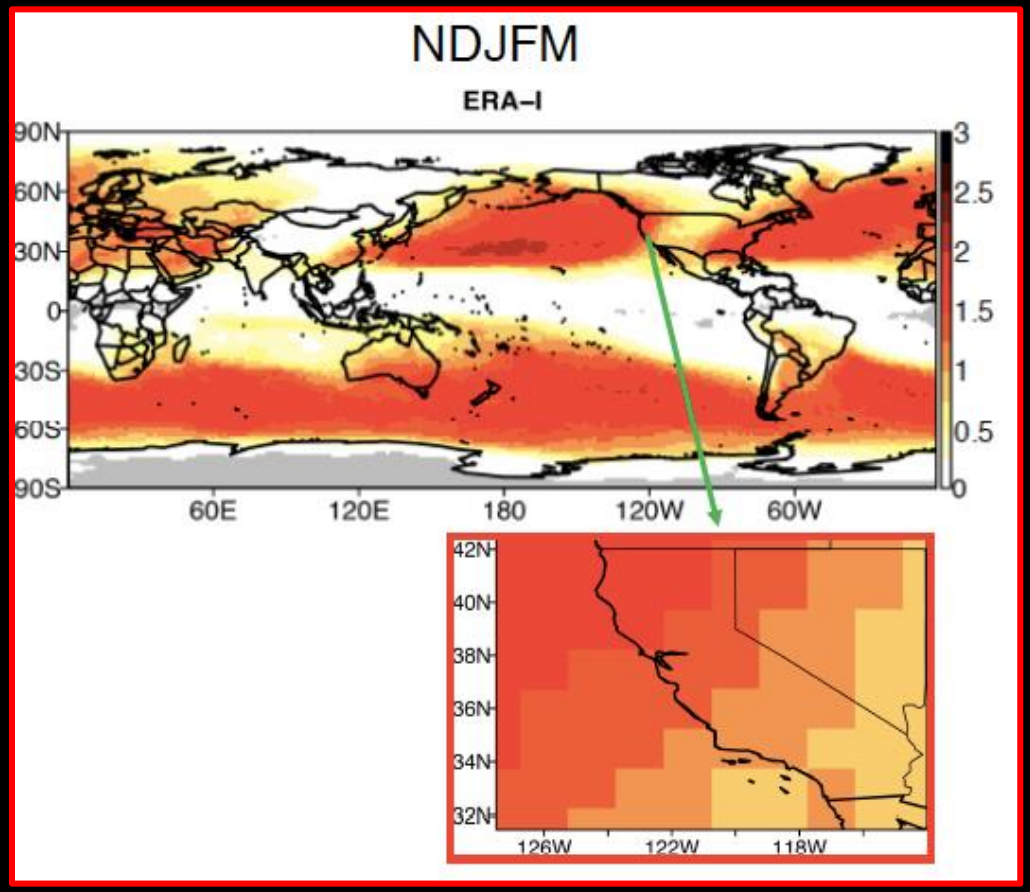
S2S Forecasts: ARs
Predicting *More or Less than Usual*

Typical #ARs in 2 Week Period



DeFlorio, Waliser, Guan, Vitart, Ralph (2017)

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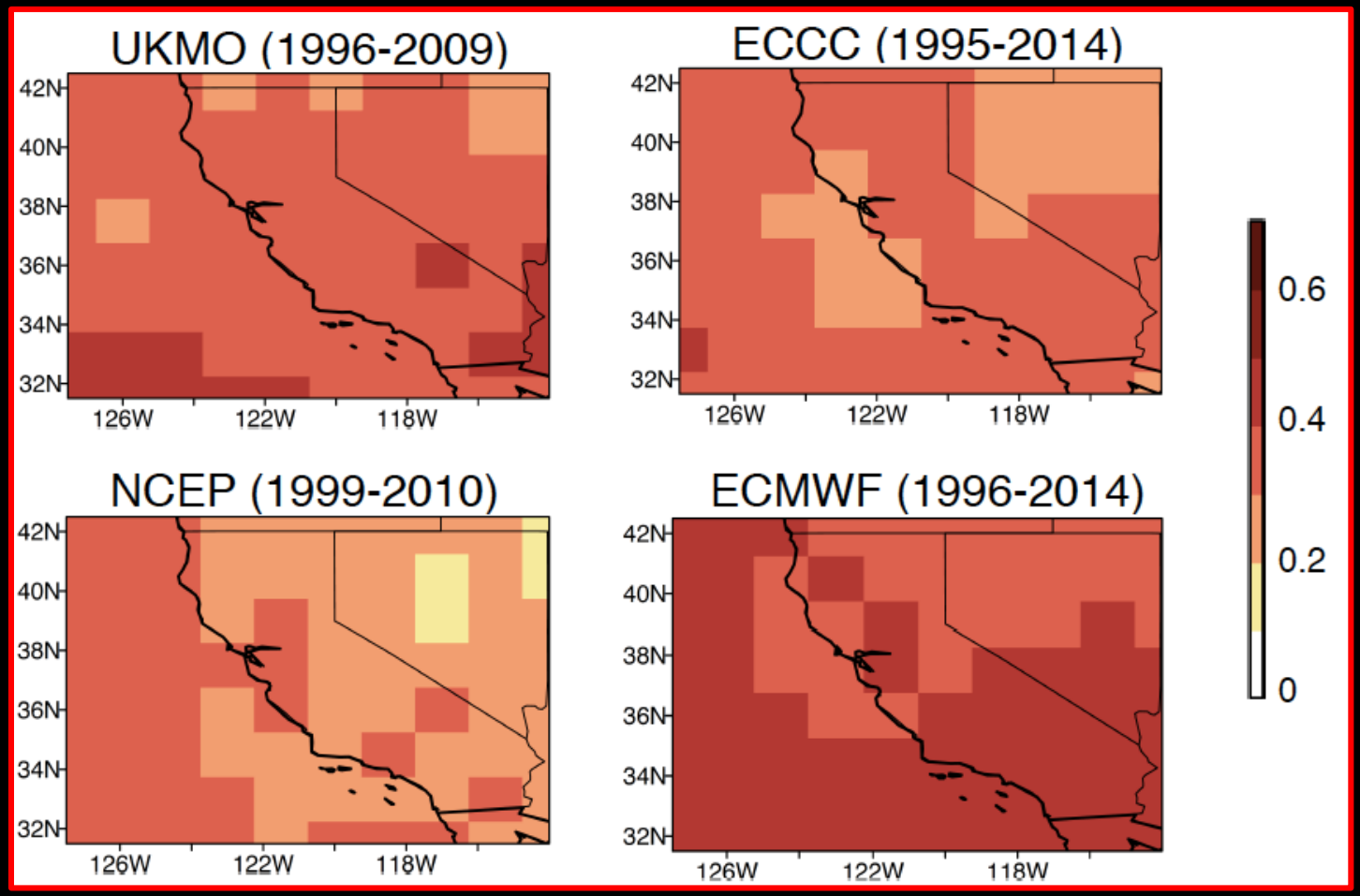
S2S Forecasts: ARs

On average - How good are today's S2S models in forecasting #ARs in weeks 2&3?



DeFlorio, Waliser, Guan, Vitart, Ralph (2017)

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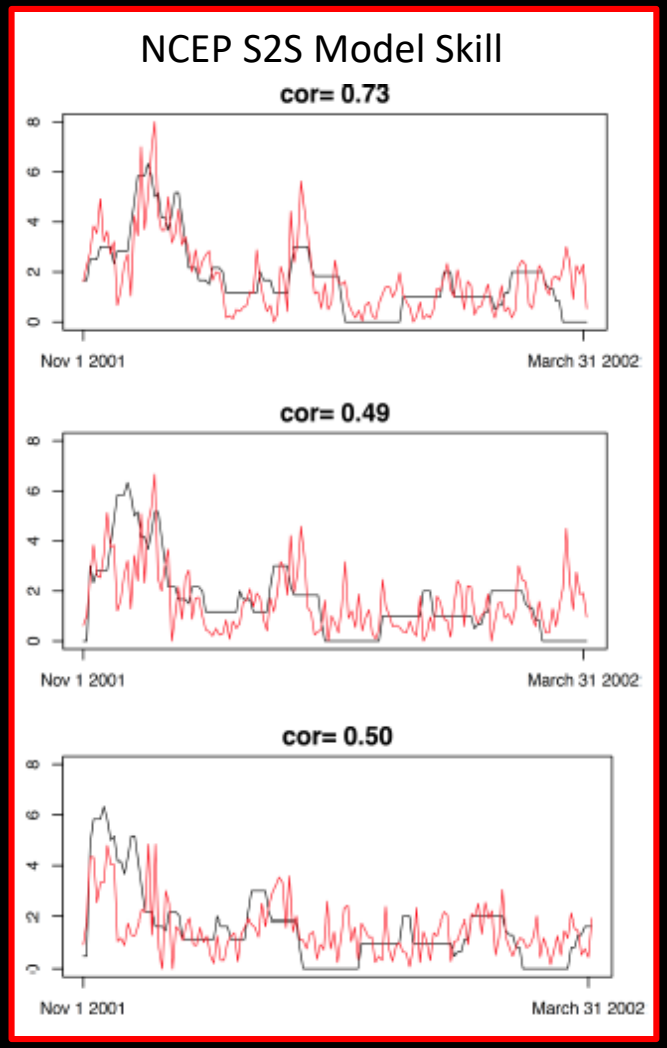
S2S Forecasts: ARs

"Orville Dam" Region



#ARs in Weeks 1&2

#ARs in Weeks 2&3

#ARs in Weeks 3&4

DeFlorio, Waliser, Guan, Vitart, Ralph (2017)

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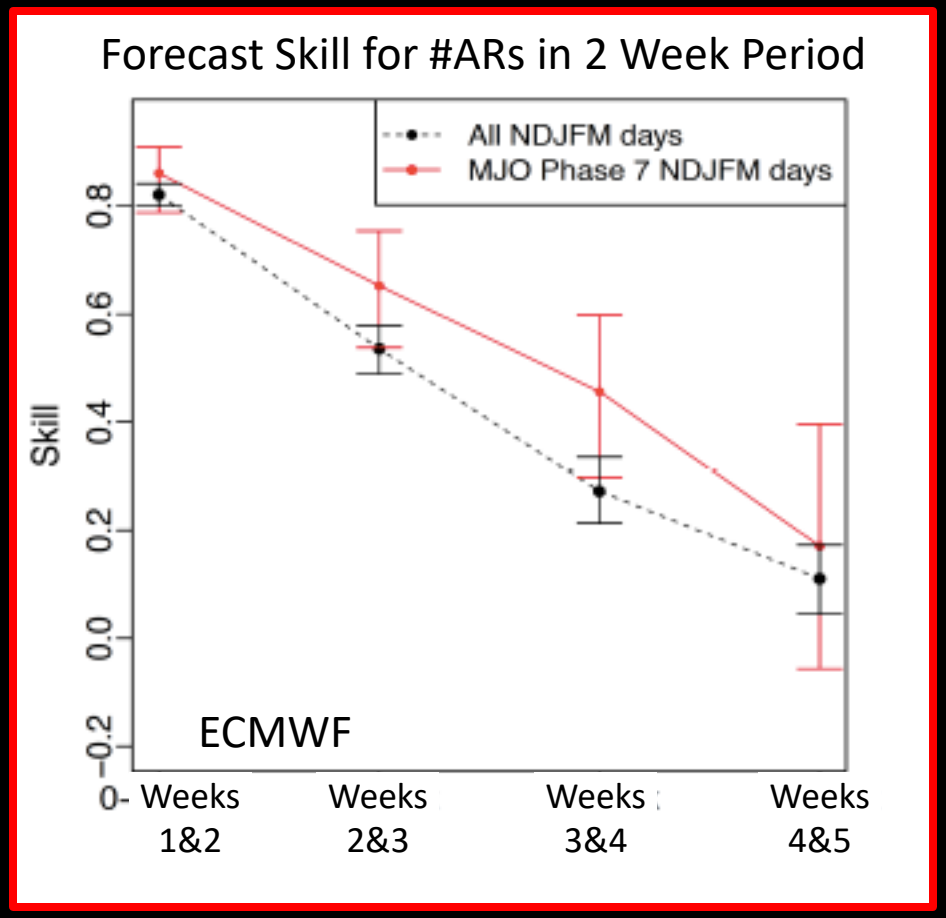
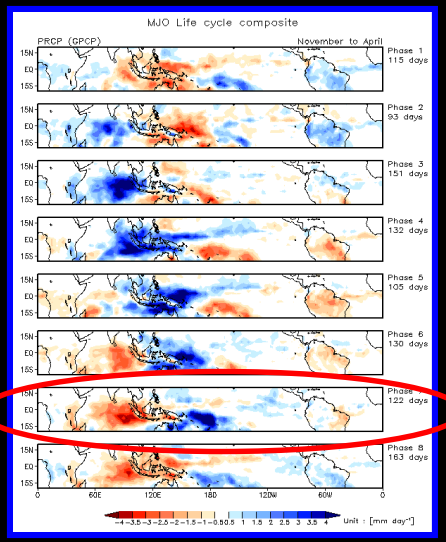
S2S Forecasts: ARs

Northeast Pacific / W. Coast



Forecast skill goes up if MJO is in Phase 7



DeFlorio, Waliser, Guan, Vitart, Ralph (2017)

Future Activities

- Continue fundamental research on ARs, MJO, ENSO, etc and related S2S predictability science and impacts studies, with an eye toward California applications.
- In collaboration with CW^{3}E/M. Ralph and the WMO S2S Project, we are standing up an experimental S2S AR forecast activity for winter 2017-18 and 2018-19 (utilizing NCEP, EC and ECMWF forecasts).
- This activity represents one of the proposed WMO S2S Project's Pilot Application Projects.